

## Natural Control of Scale Insects in Hawaii.

BY DAVID T. FULLAWAY.

Mealybugs and scales are amongst our commonest insects, and together with their natural enemies have been the subject of investigation since the beginning of entomological work here. Indeed, the first practical work undertaken was a search for natural enemies of these destructive insects by Albert Koebele, the entomological explorer. Between 1891 and 1908 he made repeated consignments of Coccinellid beetles, parasitic Hymenoptera, etc., to Hawaii, some of which were able to multiply and spread; others failing. A record of this work was preserved in letters, reports, specimens, etc., but it is meagre in detail and faulty through misidentification of either enemy or host. The list of scale insect parasites and their hosts published by the writer in 1912 perpetuates many of the original errors and adds some new ones. Since that date, however, a thorough review of the subject has been made with Mr. P. H. Timberlake, who has a wide knowledge of the parasites and their relationships, and these errors have been corrected or eliminated as far as possible in the list which follows. There can scarcely be any doubt that many of the hymenopterous parasites were introduced here unintentionally with their hosts, before the days of horticultural inspection and quarantine, for there are few records of introductions, and Mr. Koebele states that he made little effort to secure them. On the other hand, the Coccinellid beetles were practically all introduced by Mr. Koebele or others, only four being known here previous to his time.

Scale Insect Parasites in 1912 Rpt. Haw. Exp. Sta. Errata.

- p. 26      *Apentelicus* gen. nov. = *Microterys*. *Lepidosaphes* sp., given as the host of (*Apentelicus*) *M. koltinskyi* incorrect.
- p. 27      *Odonaspis graminis*, given as the host of *Adelencyrbus odonaspidis*, should be *Odonaspis ruthae*.

- p. 28 l. 12 *Anagyrus* sp.=*Pauridia peregrina*. The host is *Pseudococcus kraunhiae*.
- 13 *Encyrtus fuscus*. *Infelix*, not *fuscus*. Vide Proc. Haw. Ent. Soc. III (5), p. 403.
- 14 *Encyrtus* sp. with banded antennae=*Anagyrus swezeyi*. *Saissetia* sp., given as the host, incorrect; should be *Trionymus insularis*.
- 17 *Blepyrus insularis*. *Mexicanus*, not *insularis*. *Pseudococcus virgatus* the only host. *P. aonidium* incorrectly reported. loc. cit.
- 19 *Aphycus* sp. Later described as *Aphycus terryi*. Not congeneric with *Aphycus*; transferred to *Pseudococcobius*. The host is *Pseudococcus saccharifolii*; *P. calceolariae* not now credited to the islands.
- 20 *Aphycus* sp. on *Lepidosaphes* sp. A misidentification of either parasite or host.
- 26 *Microterys* (*Apeutelicus*) *kotinskyi* on *Lepidosaphes* sp., supra.
- 27 *Adelencyrtus odonaspidis* on *Odonaspis graminis*, supra.
- 28 *Cerapterocerus* sp. Two species are believed to be included under this name; one is probably *Auicetus annulatus*, reared from *S.hemispherica*, the other is supposed to be *Comperiella bifasciata*, reared from certain diaspine scales.
- 30 *Hemencyrtus* sp.=*Quaylea aliena*, a hyperparasite on *Saissetia nigra* through *Microterys kotinskyi* and *Scutellista cyanea*.
- 32 *Eucyrtus* sp.=*Pauridia peregrina*. Supra.
- p. 29 l. 2 *Aneristus ceroplastae* incorrectly determined; should be *Prococophagus orientalis*, loc. cit., p. 404.

- 3 *Coccophagus orientalis* now *Prococcophagus orientalis*, supra. *Pseudococcus* sp., given as host, incorrectly reported.
- 5 *Coccophagus lecanii* on *Aspidiotus rapax*. The parasite is incorrectly determined; is probably a sp. of *Prospaltella*.
- 7 *Thysanus* sp. incorrectly determined; should be *Signiphora* sp. *Aspidiotus cydoniae* is the host; *Asterolecanium pustulans* incorrectly given.
- 9 *Aphelinus diaspidis*. Two species of *Aphelinus* are now recognized on scale insects, *A. fuscipennis* and *A. limonus*. What was determined as *A. diaspidis* is probably one or the other of these.
- 13 *Aphelinus* sp. (wingless) probably incorrectly determined; may be *Perissopterus* sp. *Lepidosaphes* sp., given as the host, a misidentification; should be *Pinnaspis buxi*.
- 14 *Pteroptrichoides perkinsi* on Coccid n.g. et sp. The host referred to is a diaspine scale on Bombay mango (supposed to be *Leucospis indica*). The parasite has also been reared from *Morganella longispina*.
- 15 *Pteroptrichoides* sp. Later described as *Pseudopteroptrix imitatrix*. *Howardia biclaris* is the host; *Asterolecanium pustulans* incorrectly given.
- 24 records three parasites reared from *Asterolecanium pustulans*. It is believed the host was misidentified with respect to the two first. The last record is correct.

LIST OF SCALE INSECTS AND THEIR NATURAL ENEMIES.

HOST	PARASITE	PREDATOR
Menophlebinæ		
<i>Icerya purchasi</i>		<i>Noris carduiidis</i> (1)
Ortheziinæ		
<i>Orthezia insignis</i>		<i>Hyperaspis jocosa</i> (2)
Dactylopiinæ		See fn.
<i>Asterolecanium pustulans</i>	{ <i>Tomocera californica</i> * + <i>Quaylea aliena</i> *}	
<i>Antonina indica</i>	{ <i>Perissopterus</i> spp. (2)* { <i>Anagyrus antoninae</i> * <i>Aphycormorpha araucariae</i> *}	
<i>Eriococcus araucariae</i>	{ <i>Xanthoencyrtus apternis</i> * { <i>Anagyrus swezeyi</i> * ( <i>Perissopterus</i> spp. (2)	<i>Scymnus ocellatus</i> °
<i>Trionymus insularis</i>		<i>Cryptolaemus montrouzieri</i> (3)
<i>Pseudococcus bromeliae</i>		<i>Scymnus bipunctatus</i>
<i>Pseudococcus krambiae</i>	<i>Pauridia peregrina</i> * <i>Tanomastix abnormis</i> * (1)	

\* Reared.

° Recorded but not confirmed.

fn. *Scymnus debilis* is a predator on dactylopiine species.

(1) Introduced 1890 from California.

(2) Introduced 1908 from Mexico.

(3) Introduced about 1894 from Australia.

(4) Introduced 1915 from California.



LIST OF SCALE INSECTS AND THEIR NATURAL ENEMIES—Cont'd.

HOST

*Ceroplastes rubens*

*Eucalyptus tessalatus*

*Coccus longulus*

*Coccus viridis*

*Saissetia hemispherica*

PARASITE

*Microterys kotinskyi*\*

*Tomocera californica*

*Tomocera ceroplastis* (7)

*Prococophagus orientalis*

*Anicetus annulatus*\*

*Microterys kotinskyi*\*

*Aphygus alberti*\*

*Prococophagus orientalis*\*

*Microterys kotinskyi*\*

+*Quaylea aliena*\*

*Coccophagus lecanii*

*Coccophagus ochraceus*

*Prococophagus orientalis*

*Scutellista cyanea*\* (9)

+*Quaylea aliena*\*

*Encyrtus infelix*\* (10)

*Encyrtus barbatus*\*

*Anicetus annulatus*° (11)

\* Reared.

° Recorded but not confirmed.

(7) Recorded by Perkins 1906 but not collected since.

(9) Introduced 1905 from California.

(10) Reintroduced 1915 from California.

(11) *Cerapterocerus* sp. recorded, is believed to be identical with *Anicetus*.

LIST OF SCALE INSECTS AND THEIR NATURAL ENEMIES—Cont'd.

HOST

*Saissetia nigra*

PARASITE

*Encyrtus infocis*\*\*

*Encyrtus barbatus*\*\*

*Scutellista cyanea*\*\*

+ *Quaylea aliena*\*\*

*Procerophagus orientalis*\*\*

*Microterys kolinskyi*\*\*

*Tomocera californica*\*\*

*Scutellista cyanea*

+ *Quaylea aliena*

*Tomocera californica*°

See fn.

*Pseudopteroptria imitatrix*\*\*

*Aphelinus fuscipennis*!

*Aphelinus diaspidis*°

*Aphelinus limonis* (12)

*Aspidiotiphagus citrinus* (12)

*Saissetia oleae*

Diaspidinae

*Howardia biclaris*

*Diaspis bromeliae*

\* Reared.

° Recorded but not confirmed.

(12) Recorded by Kolinsky with slide mount of parasite.

fn. *Sticholotus punctatus* (introduced from China and Japan 1895). *Pentilia nigra* (introduced from Japan 1895), *Cyrene nigellum* (introduced about 1894 from Australia) and *Chilocorus circumdatus* (introduced 1895 from S. China) are predators on diaspine scales. *Sphaerostilbe coccophila*, a fungus disease of diaspine scales, introduced from Florida 1899-1900.

## LIST OF SCALE INSECTS AND THEIR NATURAL ENEMIES—Cont'd.

HOST	PARASITE	PREDATOR
<i>Diaspis echinocacti</i>	<i>Aphelinus fuscipennis</i> (13) <i>Aspidiotiphagus citrinus</i> (14) <i>Aphelinus diaspidis</i> ° <i>Aspidiotiphagus citrinus</i> (12) <i>Aspidiotiphagus citrinus</i> <i>Aphelinus limonus</i>	<i>Lindorus lopanthae</i>
<i>Aulacaspis rosae</i>	<i>Aphelinus fuscipennis</i> (12) <i>Aspidiotiphagus citrinus</i> (15) <i>Aphelinus limonus</i>	
<i>Phenacaspis eugeniae</i>	<i>Aspidiotiphagus citrinus</i>	
<i>Hemichionaspis minor</i> ( <i>rhododendri</i> )	<i>Aspidiotiphagus citrinus</i>	
<i>Pinnaspis buxi</i>	<i>Aspidiotiphagus citrinus</i>	
<i>Aspidiotus cyanophylli</i>	<i>Aspidiotiphagus citrinus</i>	
<i>Aspidiotus cydoniae</i>	<i>Signiphora</i> sp. (11) <i>Signiphora</i> sp. <i>Aphelinus limonus</i> (12) <i>Aphelinus fuscipennis</i> (14)	

\* Reared.

° Recorded but not confirmed.

(12) Recorded by Kotinsky with slide mount of parasite.

(13) Reared by Ehrhorn and Fullaway. Recorded by latter as *diaspidis*.

(14) Recorded by Ehrhorn with slide mount of parasite.

(15) This may be a species of *Perissopterus*; *Perissopterus chinensis* introduced 1906 from S. China.



LIST OF SCALE INSECTS AND THEIR NATURAL ENEMIES—Cont'd.

PREDATOR

PARASITE

HOST

<i>Aspidiotus rapae</i>	<i>Prospaltella</i> sp. (12)	
(sp.)	<i>Perissoplerus</i> sp. (12)	
<i>Aspidiotus</i> sp.	<i>Pseudopteroptrix imitalatrix</i> (12)	
on <i>Bombax ceciba</i>	<i>Comperiella bifasciata</i> (12) (16)	
<i>Leucospis indica</i>	<i>Aphelinus</i> sp. (12)	
<i>Monyauella longispina</i>	<i>Comperiella bifasciata</i> (12) (16)	
<i>Chrysomphalus acridum</i>	<i>Pteroptrichoides perkinsi</i> (12)	
<i>Chrysomphalus rossi</i>	<i>Pteroptrichoides perkinsi</i> *	
<i>Odonaspis rufhae</i>	<i>Prospaltella koebeli</i> (17)	
<i>Lepidosaphes auriculata</i>	<i>Aspidiotiphagus citrinus</i> *	
( <i>evolutis</i> )	<i>Aphelinus fuscipennis</i> ?	
<i>Lepidosaphes beckii</i>	<i>Aphelinus limonus</i> *	
	<i>Adelencyrtus odonaspidis</i> *	
	<i>Aphelinus limonus</i> (12)	
	<i>Aspidiotiphagus citrinus</i> (12)	
	<i>Aphelinus limonus</i>	<i>Lindorus lapanthae</i>
	<i>Aspidiotiphagus citrinus</i>	

\* Reared.

† Recorded but not confirmed.

(12) Recorded by Kötinsky with slide mount of parasite.

(16) Introduced 1908 from Japan.

(17) Reared by Koebeli.

LIST OF SCALE INSECTS AND THEIR NATURAL ENEMIES—Cont'd.

HOST	PARASITE	PREDATOR
<i>Parlatoria ziziphus</i>	<i>Aspidiotiphagus citrinus</i> *	<i>Oreus chalybeus</i> (18)
<i>Pseudoparlatoria giffardi</i>	<i>Aspidiotiphagus citrinus</i> (12) <i>Aphelinus limonius</i> (12)	

\* Reared.

(12) Recorded by Kotinsky with slide mount of parasite.

(18) Introduced 1894 from Australia.